Health Consultation

Evaluation of Exposure to Chromium in Soil and Dust: Residential Property Spur Industries Spokane, Spokane County, Washington CERCLIS ID# WAD076638527

May 17, 1999

Prepared by
Washington State Department of Health
under cooperative agreement with the
Agency for Toxic Substances and Disease Registry

Washington State Department of Health

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FOREWORD

The Washington State Department of Health (DOH) has prepared this exposure investigation under cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). The goal of DOH and ATSDR is to identify and mitigate adverse human health effects resulting from exposure to hazardous substances in the environment. This report was prepared in accordance with methodologies and guidelines developed by ATSDR.

Exposure investigations involve the collection and analysis of site-specific information to determine if human populations have been exposed to hazardous substances in the environment at levels of health concern. The site-specific information may include (1) environmental sampling, such as the collection of soil, water, air, or dust; (2) biologic or biomedical testing, such as the collection of blood or urine samples, to provide information on current (and sometimes past) exposures to a contaminant; (3) exposure-dose reconstruction, which utilizes environmental sampling information and computer models to estimate contaminant levels that people may have been exposed to in the past or may be exposed to in the future; and/or (4) evaluation of medical information.

For additional information regarding this exposure investigation report, contact

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BACKGROUND AND STATEMENT OF ISSUES

ATSDR agreed to conduct an exposure investigation to evaluate whether health concerns expressed by a Spokane County resident (petitioner) and her family may be attributable to exposure to chromium emissions from Spur Industries, a neighboring chrome plating and metal refinishing facility. Spur Industries is immediately west of and adjacent to the residence, in Trentwood, Washington. The suspected source of the chromium emissions is a stack approximately 6 meters high, located on Spur's property, approximately 20 meters from the petitioner's house. The family's specific health concerns relate to the skin, the upper respiratory tract, the sinus tract, and the gastrointestinal organ systems. The family consists of four adults (two females and two males) and four children. At the time of the sampling, only the petitioner and her son lived at the residence, although the petitioner's daughter and grandchildren frequently visited and spent considerable time there. The family occupied the residence from 1977 to 1997 and currently resides out of state. The residence was recently occupied by new residents. The petitioner recently informed DOH that since moving out of state, the family no longer suffers the health problems described above. A more detailed description of the family members and the family's specific health concerns are in the July 1996 ATSDR medical consultation.

On May 28-29, 1996, ATSDR staff from Atlanta conducted a site visit of Spur Industries and interviewed six of eight family members. ATSDR staff gathered information and discussed public health concerns with officials from the Washington State Department of Health (DOH), the Spokane County Health District, the Spokane County Air Pollution Control Authority (SCAPCA), and the owners of Spur Industries. Conference calls were held with EPA, SCAPCA, and three occupational and environmental medicine physicians to clarify and supplement existing information.

The May 1996 site visit and subsequent medical consultation prepared by ATSDR staff did not include collection of chemical or biological samples. The medical consultation concluded that the information submitted to ATSDR at the time of the consultation did not support an association between stack emissions and symptoms expressed by the petitioner's family. The consultation also stated that data gaps existed which needed addressing before more definitive conclusions about these potential associations could be drawn. To supplement historical, ancillary, and toxicological data gaps, the following recommendations were made:

1. **Collect surface soil samples from the family's yard and analyze for total chromium to determine whether exposures from Spur Industries have occurred or are occurring at levels of human health concern.**

2. **Collect ambient air samples for hexavalent chromium [Cr(VI)] to determine current exposure.**

3. **Obtain a comprehensive medical evaluation for each family member by an occupational and environmental medicine physician.**

4. Obtain complete exposure and occupational histories for each family member.
***This exposure investigation report addresses the second recommendation*, which summarizes and evaluates the results of ambient air samples collected on the subject property to determine current exposure. Soil and dust samples were collected at the residence in September 1996 and tested for total and hexavalent chromium. The results are presented in a separate report prepared by DOH.**

SPUR INDUSTRIES

Spur Industries is a metals manufacturing facility, located about 10 miles east of Spokane, Washington (Figures 1 and 2). The site property is approximately 5 acres and contains four manufacturing buildings (Figures 3 and 4). The facility began operating in 1979 and currently employs about 33 people. The chrome-plating operation has existed since 1981. Operations are conducted 20 hours per day, 5 days per week. Spur Industries is situated in a mixed industrial/residential area. The facility obtains water from the Consolidated Irrigation District, a public system. Sanitary discharges are made to a septic tank and leachfield.

Spur's industrial processes include the following:

Building 1: Manufacturing of bimetallic transition inserts. This process involves the bonding of aluminum and other metal, such as steel or copper, and also includes welding, machining, metal cutting, and metal sanding.
Building 2: Chrome plating operation. This building contains the chrome plating, rinse, and filter ion tanks. It also houses the dry chrome product.
Building 3: Machining of aluminum and wood pallet manufacturing.
Building 4: Sanding and buffing of aluminum sheets. Plates are labeled with an ink jet printer (ink-marking).

Potential contaminants from the chrome plating process includes hexavalent chromium, chromic acid, and sulfuric acid. Bag houses are located in buildings 1, 3, and 4 to collect metal sanding dust, sawdust, and aluminum dust, respectively (Figure 5). Annually, approximately 15,000 pounds of aluminum dust is collected and sold as Thermite for use in the fireworks industry.

Other hazardous materials used and hazardous wastes generated at Spur Industries include the following:

- Chrome plating solution (chromic and sulfuric acid)
- Waste ink
- Waste methyl ethyl ketone (MEK)
- Waste oil
- Waste coolant oils
- Waste solvent
- Waste alcohol
- Filtering cylinders

The U.S. Environmental Protection Agency (EPA) October 16, 1996 Preliminary Assessment Report, and the Washington State Department of Ecology (Ecology) December 9, 1996 Dangerous Waste compliance report further details Spur's industrial processes, hazardous materials storage and usage, and hazardous wastes generated.

AGENCY INSPECTIONS

The Department of Ecology conducted a Dangerous Waste compliance inspection of Spur Industries on October 31, 1996. The purpose of the inspection was to assure Spur Industries was complying with the Washington State Dangerous Waste Regulation (Chapter 173-303 WAC), which addresses the storage, handling, and disposal of hazardous wastes and materials. During the inspection, Ecology representatives noted 28 drums of accumulated chrome plating solution on site. At the time of the inspection, Spur Industries indicated they would install a hard-plumbed Aceramic pot® system that would return the used plating solution to the original process. During the same inspection, Ecology representatives also noted the practice of on-site burning of waste rags containing the organic solvent methyl ethyl ketone (MEK). Spur Industries indicated they would properly manage their waste rags.

In November 1996, the U.S. EPA, Superfund Technical Assessment & Response Team (START) published a final Preliminary Assessment (PA) report for the Spur Industries site. The specific goals of the assessment were to:

- Determine the potential threat to public health or the environment posed by the site.
- Determine the potential for a release of hazardous constituents into the environment.
- Determine the potential for placement of the site on the National Priorities List (NPL).

In the PA report, the EPA recommended that Spur Industries not be considered for inclusion on the National Priorities List (NPL).

METHODS

Background and residential site ambient air monitoring for chromium occurred during the week of January 6, 1997. The Environmental Protection Agency Region 10 Air Unit prepared the Sampling and Quality Assurance Plan. The Spokane County Air Pollution Control Authority collected the samples. The residential sampling location was based on the EPA Environmental Response Team's air modeling analysis (Appendix F) and the sampling team's site observations. Air samples were collected in accordance with the methods outlined in the approved sampling plan (Appendix H). Residential site samples were collected between the house and detached garage, near the concrete patio (photos 1 and 2). Background samples were collected on the roof of the Spokane County Health District building in Spokane (photo 3). Two field-blank air filters were also taken to the residential site and analyzed. No sources of chromium are known to exist between the background station and the family's residence. The samplers were set to run for 10 hours per day, from 6:00 a.m. until 4:00 p.m. (overlapping the facility's 4-hour morning chrome plating operating shift) on 4 consecutive days, from January 7-10, 1997. SCAPCA staff replaced the filters nightly for the following day's run.

The lower detection limit required was 0.01 micrograms per cubic meter (: g/m^3) , corresponding to one-half the chronic inhalation Environmental Media Evaluation Guide (EMEG) of 0.02 : g/m^3 for hexavalent chromium. The sampling was designed to represent a one-time measurement of the petitioner's potential exposure to airborne chromium. Past exposure to airborne chromium emissions is unknown, and therefore cannot be evaluated.

AIR SAMPLING RESULTS

Concentrations of total chromium in residential air samples ranged from 0.0097 : g/m^3 to 0.0501 : g/m^3. (mean concentration = 0.0253 : g/m^3). Background total chromium air concentrations ranged from 0.0062 : g/m^3 to 0.0126 : g/m^3. (mean concentration = 0.0087 : g/m^3). Over the sampling period, residential chromium concentrations ranged from 1.5 to 2.5 times background concentrations. Results are presented in Tables 1 and 2.

Analysis of the field blank samples showed detectable levels or chromium. However, for this exposure investigation, only uncorrected results are presented and evaluated (Table 1).

Although air sample analysis was for total chromium, *for this exposure investigation, it was assumed that 100% of the detected chromium is in the more toxic hexavalent state*. Additionally, ATSDR or EPA inhalation reference values are not available for total chromium, only for hexavalent chromium.

Since the January 1997 air sampling event, Spur added another scrubber stage onto their stack to further reduce chromium emissions. On March 6-7, 1997, total chromium levels were measured at the scrubber outlet to demonstrate compliance with EPA's National Emission Standards for chromium emissions from chrome electroplating facilities. Results indicated that total chromium concentrations at the stack were below levels established under these standards.

A SCAPCA representative recently indicated that according to the terms of their operating permit, Spur must continue to monitor operation parameters (i.e., velocity into the system and pressure drop across the system) to assure chromium emission standards are met at the stack.

DISCUSSION

Chromium concentrations were compared to ATSDR's chronic EMEG and CREG for hexavalent chromium, and EPA's reference concentration (RfC) for hexavalent chromium. Comparison values are media-specific concentrations used to select contaminants of concern for further evaluation. Contaminant concentrations detected at or below comparison values are unlikely to pose a health threat. Contaminant concentrations exceeding comparison values do not necessarily pose a health threat, but are further evaluated to determine whether they are at levels observed to cause toxic effects (referred to as toxic effect levels) in human population and/or laboratory animal studies.

Evaluating cancer risk

For screening of chemicals, which are known or expected to cause cancer, it is assumed that no "safe" level exists, and EPA cancer slope factors are used to calculate an "estimated" cancer risk. An exposure which results in an estimated increased cancer risk of one additional cancer in a population of one million people exposed, averaged over a 70-year lifetime, is considered an acceptable risk, and is used as the screening value. In a population of one million men in the U.S., 333,000 (one in three) are expected to develop cancer from all causes in their lifetime (through 79 years of age). For U.S. women, the figure is 200,000 (American Cancer Society Facts and Figures, 1998). The additional estimated increased cancer risk means that if those one million men are exposed for 30 years to this level of the chemical, 333,001 will develop cancer. For those one million women exposed, 200,001 will develop cancer.

Evaluating non-cancer risk

To evaluate the potential for non-cancer adverse health effects resulting from exposure to chromium, concentrations were compared to EPA's RfC's for *chrome acid mists/dissolved chrome(VI) aerosols* and *chrome(VI) particulates*. RfC's are estimates (with uncertainty spanning perhaps an order of magnitude) of a daily inhalation exposure of the human population (including sensitive subgroups) that is likely to be without an appreciable non-cancer risk during a lifetime. They are derived from toxic effect levels obtained from human and laboratory animal studies. These toxic effect levels are expressed as either the lowest adverse effect level (LOAEL) or the no-observed adverse effect level (NOAEL). In human or animal studies, the LOAEL is the lowest dose at which an adverse effect is seen, while the NOAEL is the highest dose that did not result in any adverse health effects.

To account for uncertainty, the toxic effect levels are divided by safety factors (usually 100 to 1,000) to provide the more protective RfC. If a dose exceeds the RfC, the potential exists for adverse health effects. Thus, a dose only slightly exceeding the RfC would fall well below the toxic effect level. The higher the estimated dose is above the RfC, the closer it will be to the toxic effect level.

Chromium toxicity

Chromium is a naturally occurring element found in rocks, soil, plants, animals, volcanic dust, and gases. Three main forms exist: metallic chromium, trivalent chromium, and hexavalent chromium. All forms of chromium can be toxic at high levels, but hexavalent chromium is more toxic via inhalation than trivalent chromium.

Chromium is used in three basic industries, metallurgical, chemical, and refractory (heat-resistant applications). Occupational sources of chromium exposure include leather tanning, chrome electroplating, chrome alloy production, textile manufacturing, paints/pigments, photoengraving, welding of steel and alloys, and copier servicing.

Chromium can be measured in the hair, urine, serum, red blood cells, and whole blood. With relatively high exposure levels (usually occupational), chromium levels in the urine and red blood cells provide indications of exposure to compounds of hexavalent chromium, but not to trivalent compounds.

Toxicological studies: non-cancer effects

The respiratory tract in humans is a major target of inhalation exposure to chromium compounds. Long-term inhalation exposures to high or moderate levels of hexavalent chromium can damage the nose and lungs and can increase the risk of non-carcinogenic lung diseases.

Two RfCs have been developed for hexavalent chromium: one based on nasal mucosal atrophy following occupational exposures to chromic acid mists and dissolved hexavalent chromium aerosols (0.008 :g/m^3), and a second based on lower respiratory effects following inhalation of chrome(VI) particulates in rats (0.1 :g/m^3). Because *none of the chromium concentrations in air samples exceeded the RfC for the lower respiratory effects*, the remainder of the discussion will summarize the results of studies conducted for exposure to chromic acid mists and dissolved hexavalent chromium aerosols.

Studies showed that 8-hour mean exposures to chromic acid above 2 :g/m^3 may cause a transient decrease in lung function, and that short-term exposures to greater than 2 :g/m^3 may cause septal ulceration and perforation. Based on the results of this study, a LOAEL of 2 :g/m^3 (adjusted to 0.7 :g/m^3 for continuous exposure) was established for incidences of nasal septum atrophy following exposure to chromic acid mists in chrome plating facilities. In the chrome plating occupational exposure studies, no workers exposed to concentrations of chromic acid mists and dissolved chrome(VI) particulates at concentrations below 1 :g/m^3 (higher than any residential sample) complained of subjective symptoms.

There is considerable uncertainty with regard to the relevance of the nasal septum atrophy endpoint observed in the chrome plating industry to exposure to hexavalent chromium in the environment. The effects were observed in chrome platers who were exposed to chromic acid mists near the plating baths. Environmental exposures would most likely occur through contact with hexavalent chromium dusts, so exposures to chromic acid mists in the environment is considered to be unlikely. ***Since none of the air samples collected at the residence exceeded the 0.7 :g/m^3 LOAEL (the highest concentration was one fourth the LOAEL), non-cancer health effects are unlikely***.

The symptoms described by the petitioner were headaches, nausea, vomiting, and a non-pruritic, non-erythematous rash. These symptoms were not consistent with chronic exposure to hexavalent chromium, according to Felicia Pharagood-Wade, M.D., of ATSDR (Appendix E). Although one drinking water study suggests that gastrointestinal effects may occur in humans following exposures to hexavalent chromium, the levels measured were 20,000 ppb (Zhang J, Li X. 1987). This level would result in much higher exposure doses than those estimated for residents at this site.

Toxicological studies: cancer effects

Under the current guidelines (EPA, 1986), and proposed guidelines (EPA, 1996), hexavalent chromium is classified as a Group A (known human) carcinogen by the inhalation route of exposure. The Department of Health and Human Services has also determined that certain hexavalent chromium compounds are known carcinogens. Trivalent chromium compounds have not been reported as carcinogenic by any route of administration.

Results of occupational epidemiologic studies of chromium-exposed workers are consistent across investigators and study populations. Dose-response relationships have been established for chromium exposure and lung cancer. Although chromium-exposed workers are exposed to both trivalent and hexavalent chromium compounds, only hexavalent chromium has been found to be carcinogenic in animal studies. Epidemiological studies of chromate production plants in Japan, Great Britain, West Germany, and the United States have revealed a correlation between occupational exposure to chromium and lung cancer, but the specific form of chromium responsible for the induction of cancer was not identified. Studies of chrome pigment workers in the United States, England, Norway, the Netherlands, and Germany have consistently demonstrated an association between occupational chromium exposure (predominantly to hexavalent chromium and lung cancer.

Assuming 30 years of continuous exposure to hexavalent chromium at the levels monitored at the residence, a range of 1 to 6 additional cancers in a population of 10,000 persons exposed, averaged over a lifetime, would be expected. However, as actual exposures were much less than 30 years, and the exposures were not continuous, estimated increased cancer risk is likely much less.

REPRODUCTIVE AND DEVELOPMENTAL EFFECTS: Child Health Initiative

No studies were located regarding the developmental effects in humans after inhalation exposure to chromium or its compounds, and information on reproductive effects in humans after inhalation to chromium compounds is limited. Effects of hexavalent chromium exposure on the course of pregnancy and childbirth were studied in a manufacturing facility in Russia. Complications during pregnancy and childbirth were reported for women who had high levels of chromium in blood and urine, compared with a control group. Compared to their controls, women exposed to high levels of chromium in the workplace had higher incidences of postnatal hemorrhage and toxicosis. However, because these studies were generally of poor quality and results were poorly reported, no conclusions can be made regarding the potential for chromium to produce reproductive effects in humans.

No studies were available that examined reproductive outcome in animals after inhalation exposure to chromium.

CONCLUSIONS

As residential chromium concentrations were below either RfCs or LOAELS, *no adverse noncancer health effects are anticipated to result from exposure*. Although the estimated increased cancer risk was somewhat elevated when assuming the very conservative exposure assumptions noted above, the risk is much less when more realistic assumptions are used. As a result, ***no apparent public health hazard is anticipated from past exposure to chromium detected in air emissions at the residence***. The no apparent public health hazard category is used for sites where human exposure to contaminated media (i.e., air) is occurring or has occurred in the past, but exposure is below a level of health hazard. Additionally, if the site sample concentrations were corrected to account for chromium detected in the field blank samples, site concentrations would have ranged from 8% to 39% lower than values presented and evaluated in Table 1.

Exposures to higher concentrations may have occurred prior to January 1997. However, without historical sampling information, assessment of these exposures was not possible. The conservative exposure assumptions assumed in this health consultation were intended to help account for these potential past exposures.

Although it is quite possible that the slightly elevated (above background) chromium air concentrations detected at the residence were a result of stack emissions from Spur Industries, the levels were not found to pose a health threat.

RECOMMENDATIONS

1. Spur Industries or SCAPCA should notify DOH if operating parameters change which could increase the concentration of chromium emissions exiting the stack.

2. If supplementary data become available, DOH will reevaluate the need for additional follow-up.

3. Copies of this exposure investigation report and the soil and dust exposure investigation report should be provided to former residents, as well as current residents.

REFERENCES

1. Site visit by Paul Marchant, Washington State Department of Health, September 19, 1996.

2. Site visit by Ric Robinson, ATSDR, January 6, 1997.

3. SCAPCA Air Emissions Model for Spur Industries, Weston/REAC, 1995.

4. Spur Industries Chromium Analysis, Data Validation, U.S. EPA Region 10, March 14, 1997.

5. Manchester Environmental Laboratory Final Report, Chromium Air Sampling Results, March 19, 1997.

6. Toxicological Profile for Chromium, US Department of Health and Human Services, Public Health Service, ATSDR, April 1993.

7. Final Medical Consultation, Spokane County Residence, Agency for Toxic Substances Disease Registry, July 1996.

8. ATSDR Perspective on Exposure Investigations, Lee Sanderson, Ph.D., Health Assessment and Consultation Training Manual, June 1996.

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   Volume 30, Integrated Risk Information System (IRIS)

10. Dangerous Waste Compliance Inspection Report, Washington State Department of Ecology, Hazardous Waste & Toxics Reduction Program, December 9, 1996.

11. Preliminary Assessment Report: Spur Industries, Inc. Environmental Protection Agency Region X, Superfund Technical Assessment & Response Team, October 16, 1996.

12. Integrated Risk Information System (IRIS), Hexavalent and trivalent chromium, September 1998 update.

13. Exposure Factors Handbook, U.S. Environmental Protection Agency, National Center for Environmental Assessment, August 1996 Update.

14. Source Emission Evaluation, Spur Industries Hard Chrome Plating Facility, March 6-7, 1997, Amtest Air Quality, LLC.

15. American Cancer Society Facts and Figures, 1998.

16. Conversations with Ric Robinson, ATSDR; Mike LaScuola, Spokane County Health District; Lynn Maser, Washington State Department of Ecology; Lynn Wilder, ATSDR; Chris Hall, U.S. EPA Region 10; Washington State Department of Labor and Industries Laboratory, Kelle Vigeland, SCAPCA; petitioner.

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CERTIFICATION

This Health Consultation for the Spur Industries Site was prepared by the Washington Department of Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was begun.

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Technical Project Officer
Superfund Site Assessment Branch (SSAB)
Division of Health Assessment and Consultation (DHAC)
ATSDR

The Division of Health Assessment and Consultation, ATSDR has reviewed this health consultation, and concurs with its findings.

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Richard Gillig
Section Chief, SSAB, DHAC, ATSDR

APPENDIX A
GLOSSARY

EMEG
ATSDR's Environmental Media Evaluation Guide. A concentration in air, soil, or water (or other environmental media), which is derived from ATSDR's MRL, and below which adverse non-cancer health effects are not expected to occur. Separate EMEGs can be derived to account for acute, intermediate, or chronic exposure durations.

MRL
ATSDR's Minimal Risk Level. An estimate of daily human exposure to a chemical that is likely to be without an appreciable risk of adverse non-cancer health effects over a specified exposure duration. MRLs are derived when reliable and sufficient data exist to identify the target organ(s) of effect or the most sensitive health effect(s) for a specified duration via a given route of exposure. MRLs are based on human and/or animal studies. MRLs can be derived for acute, intermediate, or chronic exposure durations by the inhalation and oral routes.

CREG
ATSDR's Cancer Risk Evaluation Guide. A concentration in air, water, or soil (or other environmental media), which is derived from EPA's cancer slope factor and carcinogenic risk of 10^{-6} for oral exposure. It is the concentration that would be estimated to cause no more than one additional cancer in a million persons exposed, averaged over a lifetime.

CANCER SLOPE FACTOR
A plausible upperbound estimate of the probability of a response per unit intake of a chemical over a lifetime. The slope factor is used to estimate an upperbound probability of an individual developing cancer as a result of a lifetime of exposure to a particular level of a potential carcinogen.

LOAEL
Lowest Observed Adverse Effect Level. LOAELs have been classified into "less serious" or "serious" effects. In dose-response experiments, the lowest exposure level at which there are statistically or biologically significant increases in the frequency or severity of adverse effects between the exposed population and its appropriate control.

NOAEL
No Observed Adverse Effect Level. In dose-response experiments, an exposure level at which there are statistically or biologically significant increases in the frequency or severity of any effect between the exposed population and its appropriate control. Effects may be observed at this dose, but were judged not to be "adverse".

APPENDIX B
DATA TABLES

TABLE 1
RESIDENTIAL AIR SAMPLE CONCENTRATIONS
TOTAL CHROMIUM (: g/m^3)

DATE COLLECTED	SAMPLE #	TOTAL CHROMIUM CONCENTRATION	SAMPLE LOCATION
1/7/97	97024565	0.0188	Between house and detached garage
1/8/97	97024567	0.0226	Between house and detached garage
1/9/97	97024569	0.0097	Between house and detached garage
1/10/97	97024571	0.0501 (highest concentration)	Between house and detached garage
		0.0253 (mean concentration)	

TABLE 2
BACKGROUND AIR SAMPLE CONCENTRATIONS:
TOTAL CHROMIUM (: g/m^3)

DATE COLLECTED	SAMPLE #	TOTAL CHROMIUM CONCENTRATIONS	SAMPLE LOCATION
1/7/97	97024566	0.0073	Roof of SCHD Bldg./Spokane
1/8/97	97024568	0.0126	Roof of SCHD Bldg./Spokane
1/9/97	97024570	0.0062	Roof of SCHD Bldg./Spokane
		0.0087 (mean concentration)	

TABLE 3
LABORATORY DUPLICATE SAMPLE CONCENTRATION
TOTAL CHROMIUM
(:g/m^3)

SAMPLE #	CONCENTRATION
97024571	0.0486

TABLE 4
ATSDR AND EPA INHALATION HEALTH-BASED COMPARISON VALUES
(:g/m^3)

CONTAMINANT	Chronic EMEG	CREG	RfC (acid mists/aerosols)	RfC (particulates)	Cancer Slope Factor	EPA Cancer Class
Total chromium	NA	NA	NA	NA	NA	A
Hexavalent chromium	0.02	0.00008	0.008 (LOAEL=0.7)	0.1	0.012	A
Trivalent chromium	NA	NA	NA	NA	NA	D

TABLE 5
RANGE OF AMBIENT ATMOSPHERIC CHROMIUM CONCENTRATIONS MONITORED IN THE U.S.
(:g/m^3)

	INDUSTRIAL AREAS	REMOTE AREAS
TOTAL CHROME	0.02-0.525	0.00005-0.0026
HEXAVALENT CHROME	0.0001-0.25	NA

TABLE 6
ESTIMATED INCREASED LIFETIME CANCER RISK

RESIDENTIAL TOTAL CHROMIUM CONCENTRATIONS (:g/m^3)	CANCER SLOPE FACTOR (CrVI)	ESTIMATED ADDITIONAL LIFETIME CANCERS
0.0501 (highest)	0.012	approximately 6 per 10,000 persons exposed
0.0097 (lowest)	0.012	approximately 1 per 10,000 persons exposed
0.0253 (mean)	0.012	approximately 3 per 10,000 persons exposed

APPENDIX C
PHOTOGRAPHS OF TSP MONITOR AT SITE AND BACKGROUND STATIONS
JANUARY 6-10, 1997

Photo 1: Setting up TSP Monitor at residence, Trentwood, WA.

Photo 2: TSP Monitor at petitioner’s property. Spur Industries is in background. Stack is visible on the chrome plating shed.

Photo 3: Background station for TSP Monitor on roof of Spokane County Health District building, downtown Spokane, WA. View is to the south.

Photo 4: View to the SE from background station, Spokane, WA.

Photo 5: View to the north from background station, Spokane, WA.

APPENDIX D
FIGURES

APPENDIX E

MEDICAL CONSULTATION
FOLLOW-UP CONCLUSIONS

APPENDIX F

SCAPCA AIR EMISSIONS MODEL FOR SPUR INDUSTRIES

Prior to the January 1997 air monitoring at the family's residence, the only information available on Spur Industries air emissions was from a model-based analysis of emissions from the Building 2 stack, which was conducted following a complaint in mid-1996. Data used to input into the model were obtained from site records and contact with the SCAPCA representative.

The modeler used the EPA Screen III model and input specific values into parameters including, but not limited to, emission rate, stack height, stack exit velocity, building height, and ambient air temperature. The model assumed an operational time of 1,111 hours per year. The model predicted that worst case ground-level concentrations would be located 31 meters downwind of the stack and that distance was used as the approximate location for the total suspended particulate air monitor. Using the 3 to 5 pound per year emission rate for hexavalent chromium (site file memo), the model predicted the worst-case ground-level downwind hexavalent chromium concentrations as follows:

3 lbs/year → 0.32 micrograms per cubic meter ($\mu g/m^3$) Cr(VI) (1 hour)
0.032 $\mu g/m^3$ (annual)
5 lbs/year → 0.54 $\mu g/m^3$ Cr(VI) (1 hour)
0.054 $\mu g/m^3$ (annual)

Ambient air levels predicted by the model indicate worst case hexavalent chromium levels *exceeding* the 0.02 $\mu g/m^3$ chronic and intermediate inhalation MRL.

A more detailed discussion of the air sampling protocol and rationale is in the December 1996 Air Sampling Plan for Spur Industries.

APPENDIX H

AIR SAMPLING AND QUALITY ASSURANCE PLAN

APPENDIX I
VALIDATED DATA PACKET FOR CHROMIUM ANALYSIS: SPUR INDUSTRIES